

A Modern Example: Northern Front Range Air Quality Study



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Air Quality

NFRAQS



- Denver urban region, 1996-1997
- Multi-sponsor research project,
managed by Colorado State University
(D. Lawson)

NFRAQS Objectives



- Goals
 - Attribute air pollution to sources
 - Support air quality management decisions
 - Apportion carbonaceous aerosol to sources
 - Determine whether Denver is ammonia-rich
 - Apportion sources of PM_{2.5}

NFRAQS Source Apportionment Methods



- 10 ambient sites in Denver area
 - 8 sites analyzed for carbon, ions, elements
 - 2 sites analyzed for “extended species”
CMB -- speciated organics
- 11 source categories measured for
“extended species” in CMB

NFRAQS Sources



- Light-duty gasoline vehicles (LDGV)
 - hot stabilized
 - cold start
 - high emitter
- Diesel exhaust
- Meat cooking
- Soft wood smoke
- Hard wood smoke
- Road dust/geologic.
- Ammonium sulfate
- Ammonium nitrate
- Coal power station

NFRAQS Model Selection



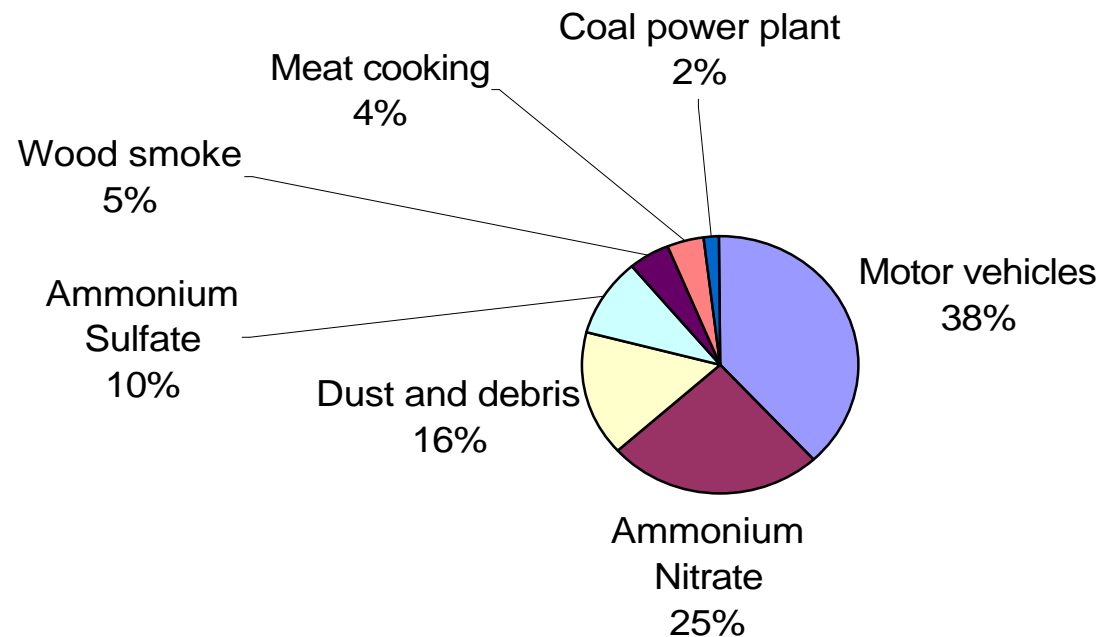
- Chemical Mass Balance
 - Combination of pre-defined source profiles that best explains ambient observations
 - “How much comes from each source?”
 - Must include all sources of analyte species

“Extended Species” CMB

- Sampled sources, analyzed PM mass fractions: PAH, other organics, EC, ions
- Determined model species
 - Distinguish sources from one another
- Analyzed ambient aerosol for same species at two “extended species” sites
- CMB model used to estimate source contributions

NFRAQS Findings

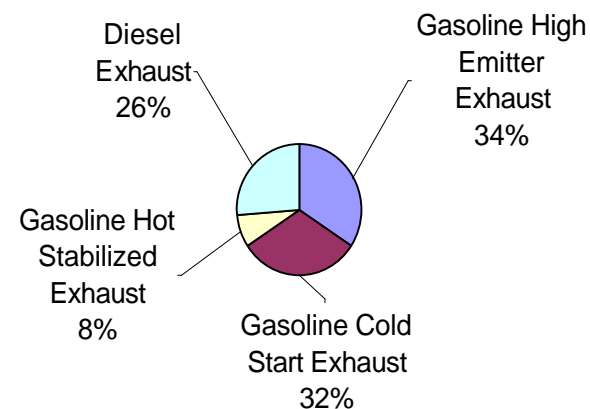
**PM-2.5 Source Contribution Estimates in Welby, CO
Winter 1997**



NFRAQS Findings

- Mobile source findings significant
- These findings are the opposite of the inventory

Mobile PM-2.5 Source Apportionment in Welby, CO



NFRAQS Implications



- Inventory does not account for some major sources
- If true, NFRAQS would indicate that inventory has mobile sources backwards!
- Inventory estimates diesels about 3x gasoline vehicles
 - No high emitting gasoline vehicles
 - No cold start gasoline vehicles

NFRAQS Implications



- New questions about high emitters
- Informing data collection in OTAQ, CARB, CRC

NFRAQS Limitations

- CMB requires that all sources of model species are characterized
 - Will still provide an answer if they aren't
- Non-road engines not included in CMB
 - A new car is not a snowmobile
 - Low vs. high sulfur diesel fuels
 - Many PAHs come from fuel
 - Welby ambient site near major rail yard

NFRAQS Limitations

- CMB assumes stable source profiles
 - Source and ambient samples must be collected and analyzed by same means
 - Exhaust vs. ambient sampling
 - For mobile sources, idle vs. driving can change composition
 - Diesel running $EC > OC$; idle: $EC < OC$

Issues for Exposure



- Many sources in human exposure studies
- CMB requires all independent sources be well-characterized and modeled
- May point to greater utility of factor analytic approach in exposure work

Conclusions



- NFRAQS introduced important new considerations in modeling
- Interpretation is informed by going back to the basics of CMB modeling
- Characterization of all independent sources is important
- Multivariate approaches may be of greater utility in exposure studies